UNITED STATES PATENT APPLICATION

FOR

METHOD AND APPARATUS TO REDUCE POWER CONSUMPTION OF A COMPUTER SYSTEM DISPLAY SCREEN

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The present invention relates to computer systems and more particularly to a power savings technique in which the brightness of portions of a display screen of the computer system may be independently adjusted to reduce power.

BACKGROUND

Computer systems are becoming increasingly pervasive in our society, including everything from small handheld electronic devices, such as personal data assistants and cellular phones, to application-specific electronic devices, such as set-top boxes, digital cameras, and other consumer electronics, to medium-sized mobile systems such as notebook, sub-notebook, and tablet computers, to desktop systems, workstations, and servers. Computer systems typically include one or more processors. A processor may manipulate and control the flow of data in a computer. To provide more powerful computer systems for consumers, processor designers strive to continually increase the operating speed of the processor. Unfortunately, as processor speed increases, the power consumed by the processor tends to increase as well. Historically, the power consumed by a computer system has been limited by two factors. First, as power consumption increases, the computer tends to run hotter, leading to thermal dissipation problems. Second, the power consumed by a computer system may tax the limits of the power supply used to keep the system operational, reducing battery life in mobile systems and diminishing reliability while increasing cost in larger systems.

One approach to reducing overall power consumption of a computer system is to change the focus of power reduction from the processor to other components that have a significant impact on power. For example, display screens of computer systems typically consume a significant amount of power. For many backlit liquid crystal display

(LCD) screens, increasing the brightness of the display screen typically increases its power consumption, and decreasing the brightness of the display screen typically decreases its power consumption. Therefore, it is generally in a user's best interest to lower the average brightness of the display screen over time.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and not limitation in the accompanying figures in which like references indicate similar elements and in which:

Figure 1 includes a computer system formed in accordance with an embodiment of the present invention;

Figure 2 includes a computer system formed in accordance with an embodiment of the present invention;

Figure 3 includes an image in accordance with an embodiment of the present invention; and

Figure 4 includes a flow chart showing a method of an embodiment of the present invention.

DETAILED DESCRIPTION

In accordance with an embodiment of the present invention, a computer system may determine focus areas and non-focus areas of the display screen. The brightness of non-focus areas may then be reduced with respect to focus areas, thereby reducing power consumption of the display screen and, hence, reducing power consumption of the computer system. For example, a focus area may be an active window of the

display screen and a non-focus area may be an inactive window of the display screen. As another example, a focus area may be a region of the display screen within a vicinity of a cursor (i.e. data entry point), and a non-focus area may be the region outside this vicinity. The size of the vicinity may be measured in radius from the cursor or in lines of text above and/or below the line containing the cursor (e.g. in a word processing or spreadsheet program). The size and shape of the vicinity may be determined by a user.

A more detailed description of embodiments of the present invention, including various configurations and implementations, is provided below.

Figure 1 includes a computer system that may be formed in accordance with an embodiment of the present invention. As shown, the computer system may include a processor 100 coupled to hub 110. Processor 100 may communicate with graphics controller 105, main memory 115, and hub 125 via hub 110. Graphics controller 105 may be coupled to display screen 145. Hub 125 may couple peripheral device 120 (which may be any one or more of a number of input/output devices), storage device 130, pointer/cursor control 135, and camera 165 to hub 110.

In accordance with one embodiment of the present invention, pointer/cursor control 135 of Figure 1 may include, for example, arrow keys on a keyboard, a mouse, a touch screen, a touch pad, a trackball, or any other pointer or cursor control device. For one embodiment, pointer/cursor control 135 may provide the user with a means by which the user may identify a focus area of the display screen, e.g. by selecting a window to activate or by determining a data input position in a document. For convenience, pointer/cursor control 135, which is intended to indicate either a pointer or

cursor control device, may be referred to herein as a cursor control device, and pointers and cursors may be collectively referred to herein as cursors.

Camera 165 of Figure 1 may also function as a cursor control device to determine a focus area on display screen 145. For example, camera 165 may provide an image of a user's face for use in determining where on the display screen the user may be looking. For one embodiment of the invention, a focus area may be the portion of the display screen at which the user is looking. In accordance with one embodiment of the present invention, camera 165 of Figure 1 may serve alternate purposes beyond focus area detection. For example, camera 165 may enable video imaging functions such as still photo capturing, video recording, teleconferencing, etc.

A method of an embodiment of the present invention may be implemented by the computer system of Figure 1 programmed to execute instructions associated with the method. These instructions may reside, at least in part, in any machine-readable medium such as a magnetic disk (e.g. a hard drive or floppy disk), an optical disk (e.g. a CD or DVD), a semiconductor device (e.g. Flash, EPROM, or RAM), or a carrier wave (e.g. an electrical or wireless data signal), all of which are collectively represented by storage device 130 of Figure 1.

In accordance with an embodiment of the present invention, a computer system may include more or fewer components than those shown in Figure 1, and the components of Figure 1 may be partitioned differently. For example, multiple components may be integrated into a single component, and single components may be divided into multiple components. Note that the term "processor" may be used herein to refer to one or more of a central processing unit, a processor of a symmetric

or asymmetric multiprocessing system, a digital signal processor, a micro-controller, etc.

Figure 2 includes a "clam shell" mobile computer system (e.g. a laptop, notebook, sub-notebook, etc.) formed in accordance with an embodiment of the present invention. The computer system includes a flat panel display screen 201, a cursor control, and a camera 202. Camera 202 may be used to provide an image to be analyzed to determine a focus area of display screen 201, as described above. In accordance with an alternate embodiment of the present invention, cursor control 203 and camera 202 may be located elsewhere on the computer system chassis or may be separated from the chassis via a wired or wireless connection.

Figure 3 includes an image on display screen 300 formed in accordance with an embodiment of the present invention, including active window 301 and inactive window 302. In accordance with one embodiment of the present invention, active window 301 may be the focus area of the display screen and the remainder of the display screen, including inactive window 302 and the surrounding region (such as the desktop, toolbars, icons, etc.), may be the non-focus area. For one embodiment, the brightness of the non-focus area of the display screen may be decreased in accordance with a display power management protocol to reduce power consumption of the display screen.

For one embodiment of the present invention, the brightness of at least a portion of the non-focus area of the display screen may be decreased to approximately zero, making the portion indiscernible. In accordance with an alternate embodiment of the present invention, the brightness of at least a portion of the non-focus area of the

display screen may be merely dimmed, making the portion obscured but still discernible. In accordance with one embodiment of the present invention, the amount by which the brightness of the portion may be decreased may be defined according to a predetermined user preference setting in the computer system. For one embodiment, a screen may include two or more separate focus areas, such as two separate windows, or two or more separate non-focus areas.

A display screen formed in accordance with an embodiment of the present invention, such as display screen 300 of Figure 3, may include a backlit liquid crystal display (LCD). For this embodiment of the present invention, the display screen may include two or more backlights, the power to which may be independently controllable. For example, for this embodiment, display screen 300 of Figure 3 may include one or more backlights behind active window 301 and one or more backlights behind the remainder of the screen.

In accordance with this embodiment, after active window 301 of Figure 3 becomes the focus area, power to the one or more backlights behind active window 301 may increase (or remain unchanged if window 301 was already bright). This has the effect of increasing the brightness of the display screen in that region. For this embodiment, power to the one or more backlights behind at least a portion of the remainder of display screen 300, e.g. at least a portion of the non-focus area, may be decreased, thereby decreasing the brightness in that region. If window 302 subsequently becomes the focus area of display screen 300, power to the one or more backlights behind window 301 may be decreased, thereby decreasing the brightness in

that region, and power to the one or more backlights behind window 302 may be increased, thereby increasing the brightness in that region.

In accordance with an alternate embodiment of the present invention, display screen 300 of Figure 3, may include one or more light emitting pixels (or sub-pixels), such as a light emitting diode (LED) or a plasma display element. For this embodiment of the present invention, the power consumption of each pixel of the display screen may increase as the brightness of the pixel increases.

Figure 4 includes a flow chart showing a method of an embodiment of the present invention. At block 405, input is received from a user. This input may be, for example, cursor control or data entry. For an alternate embodiment of the present invention, this input may be eye movement or other gesture detected by a camera of the computer system.

Next, at block 410, this user input is used to determine a non-focus area of the display screen. In response to this determination, the brightness of the non-focus area of the display screen is decreased at block 415 in accordance with a display power management protocol.

This invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident to persons having the benefit of this disclosure that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the invention. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.